The residual product was dewaxed, in which the higher fatty acids (chain lengths of C22 and higher), waxes, and other higher-boiling components contained in the oil crystallized out as solids and were separated by filtration. The filtered residual product was returned to the hydrolysis process at the first stage by a pump as indicated in Figure 1.

Some other examples were run in the same manner, including some with higher proportions of enzyme and correspondingly shorter hydrolysis times; with beef tallow, and with crambe oil. In the example with crambe oil, which contains 60% erucic acid, a mixture of the non-specific enzyme OF 360 noted above and the 1,3-specific enzyme Novozym 388 was used. The latter specifically hydrolyzes off the fatty acids bound to the 1- and 3-positions[2] of the triglyceride structure, erucic acid in this case.

Claims

1. A process for the enzymatic hydrolysis of oils and/or fats with simultaneous enzymatic formation of fatty acid esters using lipases acting as biocatalysts and alcohols, especially n- and iso-alcohols, wherein:

lipases, as biocatalysts for hydrolysis of oil or fat and formation of fatty acid esters, are caused to act on a mixture of triglycerides, water, and an alcohol soluble in oil or fat,

the reaction mixture formed in the hydrolysis process is transferred to a self-discharging centrifuge for separation into a glycerol-containing aqueous phase and an organic phase that contains the fatty acid esters which have formed,

the centrifuge is adjusted so that a lipase-enriched intermediate layer forms in the centrifuge between the aqueous phase that is drained off and the organic phase that is drained off, and

the centrifuge is emptied at specified times and the drum contents that are discharged in this process are recycled to the combined hydrolysis and esterification process or are made ready for a further hydrolysis and esterification process.

2. The process of Claim 1,

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[2] **[Translator's note: sic; actually, the "1 and 3 positions"]**

wherein
the alcohol is used in an excess of 2 to 100%, preferably 5% to 20%, based on the stoichiometric amount required for esterification.

3. The process of Claim 1 or Claim 2,
wherein
the amount of water added is at least 5% by weight based upon the organic phase employed that is comprised of oil or fat and alcohol.

4. The process of one of the foregoing Claims 1 through 3,
wherein
the alcohol used is an alcohol which is quite soluble in the organic phase formed, but is considerably less soluble in water, and especially medium-chain to long-chain n- and iso-alcohols.

5. The process of one of the foregoing Claims 1 through 4,
wherein
the fat hydrolysis/esterification is carried out discontinuously in reactors that are run in loop operation with the reactor contents circulated by pumps, with multiple reactors being provided in parallel for a single, or for each added, reaction stage, with one of the reactors being filled with the circulating loops not active, with a hydrolysis/esterification operation being run in a second reactor having active circulating loops, with a third reactor having its circulating loops not active and being emptied through a centrifuge which separates the glycerol-containing aqueous phase formed in the hydrolysis process from the organic phase containing the fatty acid esters prior to when the fatty acid esters are separated from the organic phase.

6. The process of one of the foregoing Claims 1 through 5,
wherein
non-specific lipases, specific lipases, or mixtures of non-specific and specific lipases are used as the lipase.

7. The process of one of the foregoing Claims 1 through 6,

wherein

the free fatty acids and alcohol from the organic phase are separated by distillation from the fatty acid esters that have formed and these separated free fatty acids and alcohol are returned to the hydrolysis/esterification process.

8. The process of one of the foregoing Claims 1 through 7,

wherein

the organic phase drained out from the self-discharging centrifuge is transferred to another self-discharging centrifuge, in particular a polishing centrifuge, which is likewise emptied intermittently to recover lipase residues that have collected as a sediment on the centrifuge wall for reuse in the hydrolysis process.

9. A device for carrying out the process of one of the foregoing Claims 1 through 8,

comprising

one or more hydrolysis/esterification reactors,

one or more self-discharging centrifuges in which a lipase-enriched intermediate layer collects between the aqueous phase that is drained off and the organic phase that is drained off, and which are emptied at specified times,

a feedback system for returning the intermittently discharged drum contents from the centrifuge to the combined hydrolysis and esterification process, and a

a means for separating the alcohol, free fatty acids and fatty acid esters formed from the organic phase that is supplied from the centrifuge.

10. The device of Claim 9,

wherein

the means for separation is a distillation apparatus, especially a short-path still or a falling film evaporator.

11. A process for the enzymatic hydrolysis of oils and/or fats using lipases acting as biocatalysts to obtain fatty acids and glycerol, wherein:

lipases are caused to act as biocatalysts on a mixture of an oil or fat and water to hydrolyze the oil or fat,

the reaction mixture thus produced is transferred to an self-emptying centrifuge for separation into an glycerol-containing aqueous phase and an organic phase that contains free fatty acids that have been hydrolyzed off in the preceding hydrolysis,

the centrifuge is adjusted so as to collect a lipase-enriched intermediate phase that forms in the centrifuge between the aqueous phase that is drained off and organic phase that is drained off, and

the centrifuge is emptied at specified times and the centrifuge drum contents that have been discharged are returned to the hydrolysis process or are prepared for a further hydrolysis process.

12. The process of Claim 11,

wherein

the fat hydrolysis is carried out discontinuously in reactors that are run in loop operation with the reactor contents circulated by pumps, with multiple reactors provided in parallel for a single or for each of numerous reaction stages, with one of the reactors being filled with the circulation loops not active, with a hydrolysis operation being run in a second reactor having active circulation loops, with a third reactor having its circulating loops not active and being emptied through a centrifuge which separates the glycerol-containing aqueous phase formed in the hydrolysis process from the organic phase containing the free fatty acids prior to when the fatty acids are separated from the organic phase.

13. The process of either Claim 11 or Claim 12,

wherein

the free fatty acids and alcohol are separated by distillation out of the organic phase from the fatty acid esters that have formed, and are returned to the hydrolysis/esterification process.

14. The process of any of Claims 11 through 13,

wherein

the organic phase flowing out of the self-discharging centrifuge is transferred to another self-discharging centrifuge, in particular a polishing centrifuge, which is likewise emptied intermittently to recover residues of lipase that have collected as a sediment on the centrifuge wall for reuse in the hydrolysis process.

15. A device for carrying out the process of any of Claims 11 through 14,

comprising:

one or more hydrolysis reactors,

one or more self-discharging centrifuges in which a lipase-enriched intermediate layer collects between the aqueous phase that is drained off and the organic phase that is drained off, and which are emptied at specified times,

a feedback system for returning the intermittently discharged drum contents from the centrifuge to the hydrolysis process, and a

means for separating the free fatty acids from the organic phase that is supplied from the centrifuge.

16. to the device of Claim 15,

wherein

the means for separation is a distillation apparatus, especially a short-path still or a falling film evaporator.